Joint element for pneumatic structural elements

The present invention relates to a joint element for pneumatic structural elements and associated connecting elements according to the preamble of Patent Claim 1.

Joint elements for non-pneumatic structural elements are known per se, for example going by the name of MERO systems. The task of these joint elements is to introduce tensile and compressive forces, in a manner free of bending moments, into framework structures. A pneumatic structural element is known, for example, from European Patent Application 01 903 559.1 of the same inventor. The operation of connecting the structural element described in this document to a joint using known means, however, is not without problems since bending moments produced from the reaction to bearing pressure cannot be completely avoided without excessive outlay in respect of auxiliary structural means.

The object of the present invention is to provide a joint element which allows the tensile, compressive and bearing forces to be brought together without the occurrence of local bending moments and which, furthermore, also allows the bearing forces to be introduced into known and conventional structural elements.

The solution to the set object is represented, in respect of its fundamental features, in the characterizing part of Patent Claim 1 and, in respect of further advantageous embodiments, in the subsequent patent claims.

The idea of the invention will be explained in more detail with reference to a number of exemplary

embodiments and with the aid of the attached drawing, in which:

Figure 1a shows the prior art in a schematic side view,

Figure 1b shows the prior art in a cross section,

Figure 2 shows a perspective view of a first exemplary embodiment of a joint element,

Figure 3 shows the first exemplary embodiment in a first longitudinal section,

Figure 4 shows the first exemplary embodiment in a second longitudinal section,

Figure 5 shows a second exemplary embodiment in longitudinal section,

Figure 6 shows a perspective view of a third exemplary embodiment,

Figure 7 shows a fourth exemplary embodiment in longitudinal section,

Figure 8 shows a perspective view of a first connecting element according to the invention,

Figure 9 shows a perspective view of a second connecting element according to the invention,

Figure 10 shows a perspective view of a third connecting element according to the invention,

Figure 11 shows a perspective view of a fourth connecting element according to the invention,

Figure 12 shows a perspective view of a fifth connecting element according to the invention,

Figure 13 shows a perspective view of a sixth connecting element according to the invention, and

Figure 14 shows a perspective view of a seventh connecting element according to the invention.

Figure 1a is a schematic side view of a pneumatic structural element 1 according to the prior art. It comprises a sleeve 2, a compression member 3 and two tension members 4. The sleeve 2 is produced from a woven textile fabric which does not expand to a great extent and is either coated in a gas-tight manner or is provided internally with a flexible gas tube which is made of elastic polymer material and performs the sealing function. The compression member 3, as can be seen from Figure 1b, has been pushed, for example, into a pocket 6, running along the sleeve 2 and fastened thereon by sewing and sealing, welding or adhesive bonding, and it extends over the entire, essentially cylindrical, length of the sleeve 2. At its ends, the compression member 3 is fixed to the ends of the two tension members 4, which are positioned in opposite helical directions around the sleeve 2 and abut tightly there. They may be drawn through lugs 7 fastened on the sleeve 2 in order for their position to be defined even when the sleeve 2 is slack. Joints 8 form the

connecting locations of the compression member 3 and tension members 4.

At its ends, the sleeve 2 is closed by two spherical caps 5, for example made of the same material as the sleeve 2.

Figure 2 is the perspective illustration of a first exemplary embodiment of the joint element according to the invention. The latter comprises a plate 9 with a large opening 10 for the spherical cap 5 of the pneumatic structural element 1. The plate 9 here is, for example, of square configuration and contains four lots of holes 11, 12. The four holes 12 are located in the centre of a row of holes in each case. In the hole 12 of the top row of holes in Figure 2, the compression member 3 is fastened, for example, with a screw 15, as can be seen from Figure 3; Figure 3 is the longitudinal section AA through the illustration of Figure 2; Figure 4 is the longitudinal section along section plane BB. The bores of the holes 11 run, for example, obliquely through the plate 9. In the exemplary embodiment according to Figure 2, in each case three holes 11 to the left and right of the compression member 3 are occupied by in each case one cable 16. These in each case three cables 16 are guided parallel to one another and, together, form the tension member 4 described in relation to Figure 1. The cables 16 are secured in the plate 9 by nuts 17, as is known from the technology of prestressing cables for reinforced-concrete structures. The holes 11, 12 which are occupied here are located on a straight line. Since the stressing of the cables 16 is equalized, the only bending moment is produced in the plate 9 itself; however, none is diverted to the pneumatic structural element.

In Figures 2 and 3, force arrows are designated F_A. These relate to the bearing forces. The vectors of the compressive forces, which are exerted by the compression member 3, of the tensile forces, which are produced by the cables 16, and of the bearing forces may be added together in the plate 9 to give zero, without bending moments being produced in the compression member 3. Possible materials for the plate 9 are, for example, aluminium, glass-fibre-reinforced plastics, carbon-fibre-reinforced plastics or multi-layered plywood.

Figure 5 illustrates, as a second exemplary embodiment, a further configuration of the first exemplary embodiment. The plate 9, once again, has the large opening 10, albeit of particular design: in a first portion 18, the opening 10 is of a cylindrical configuration and contains a first O-ring groove 19 with a first O-ring 20. The latter provides sealing against the outside of the cylindrical part of the sleeve 2. The first cylindrical portion 19 is adjoined by a second portion 21, which essentially has the form of the spherical cap 5 located in the opening 10. Instead of the spherical cap 5, a cover 22 modelled, for example, on the spherical cap 5 is provided here. It is also possible - depending on expediency - for this cover to be formed in some other way; it is only its essentially conical or spherical profile within the second portion 21 which is essential to the invention.

Also within the cylindrical part of the first portion 18, the cover 22 is likewise cylindrical and, there, contains an O-ring groove 23 with a second O-ring 24, which provides sealing against the inside of the cylindrical part of the sleeve 2. The sleeve 2 is clamped in between the plate 9 and the cover 22, in the conical or spherical part 21 of the opening, by the

cover 22, and the latter is forced against the plate 9 by the positive pressure prevailing in the sleeve 2. The sealing function is performed, as has been described, by the two O-rings 20, 24. The rest of the plate 9 may be configured in accordance with Figures 2, 3 and 4.

It is, of course, also possible for the cover 22, instead of being of spherical configuration, to have some other, for example planar, form, along with corresponding reinforcement of the wall.

A third exemplary embodiment of the joint element according to the invention is illustrated in Figure 6. It is provided for a pneumatic structural element 1 with a plurality of - in this case eight - compression members 3 and, by way of example, two tension members 4 per compression member 3. The plate 9 here is designed as a round flange 27 with a large opening 10 for the spherical cap 5 of the pneumatic structural element 1. The flange 27 contains, in accordance with the number of compression members 3, holes 12 for the screws 15 for fastening the compression members 3. In accordance with the number of tension members 4 per compression member 3, the flange 27 contains holes 11 for fastening the tension members 4.

In the exemplary embodiment according to Figure 6, the flange 27 does not contain any further holes. For fastening on further static structures and for the introduction of supporting forces, the flange 27, or a round plate 9 in general, can be clamped into a plate 28, as is illustrated in section in Figure 7. The plate 28 here contains, for example, a circular opening 31 for accommodating the flange 27. A further, for example circular plate 29 contains an opening 32. Both plates 28, 29 are provided with a circular shoulder 33 which

fits with the necessary amount of accuracy over the flange 27 and accommodates the latter. By means of screws 30, the two plates 28, 29 can be fastened in a force-fitting and form-fitting manner on one another. The external form of the plate 28 may be round, quadrilateral or polygonal, depending on the structural and design-related requirements. It may, furthermore, contain a multiplicity of holes 34 for fastening the pneumatic structural element 1 on further static structures and for introducing supporting and bearing forces.

Of course, it is also possible for the plate 9 according to Figures 2, 3, 4 and 5 to be of circular configuration and to be encased by means of the plates 28, 29 described in relation to Figure 7.

The possible formations either of the plate 9 itself - as has already been illustrated in Figure 2 - or of the plate 28 according to Figure 7 belong to the joint element according to the invention.

Quadrilateral, or if need be square, plates 9, 28 can be used for connecting elements according to Figures 8, 9, 10 and 11, as is shown hereinbelow. If one or, at most, four pneumatic structural elements 1 is or are to be positioned, for example, on a column 40, as is illustrated in Figure 8, then use may be made, for example, of a cubic connecting element 41. The plates 9, 28 are screwed onto the suitably designed connecting element 41. The pneumatic structural elements are only illustrated schematically; this is not associated with any restriction in their design.

A variant of this is shown in Figure 9. Here, use is made of a connecting element 42 of triangular cross

section for connecting, at most, three pneumatic structural elements 1.

The exemplary embodiment of Figure 10 is conceived for connecting, at most, six pneumatic structural elements 1. Accordingly, a connecting element 43 has a hexagonal horizontal projection with preferably square side surfaces. Designing the side surfaces as squares has the advantage that, if the pneumatic structural elements 1 are equipped with four, eight or twelve compression members 3, there is no need to ensure correct orientation. If, however, a certain orientation is to be maintained, then this can be made certain by the provision of a protuberance 44, as is illustrated in Figure 9. To summarize the configuration of the connecting elements 41, 42 and 43, their horizontal projection may be defined as polygonal, the bottom and top surfaces of the connecting elements 41, 42 and 43 being of equal magnitude and the pneumatic structural elements 1 fastened thereon all being located in the same plane.

Figure 11 shows a further exemplary embodiment of a planar arrangement of pneumatic structural elements 1. In this case, the, for example, square plates 9, 28 are screwed one beside the other to a carrying element (not illustrated). Such carrying elements, as structures which are known per se, do not form a constituent part of the invention. This arrangement can be used to produce, for example, a roof surface.

Figures 12, 13 and 14 are illustrations of non-planar arrangements. Figure 12 shows a connecting element 45 which is, for example, of curved configuration. It is, furthermore, configured such that it can perform the function of the plate 28, that is to say the connecting element 45 here has five circular openings 31 and, for

example, six holes for screws 30 per opening 31. By means of these screws, the further plate 29, which belongs to each pneumatic structural element 1, but is not illustrated in Figure 12, is screwed to the connecting element 45.

In the exemplary embodiment according to Figure 13, a plurality of pneumatic structural elements are connected to a connecting element 46 which is configured as a polyhedron - in this case an octahedron. The pneumatic structural elements are attached to the connecting element 46 in the same way as has been explained in relation to Figure 12. As an alternative to this, it is also possible for each plate 9, 28 to be in the form of the corresponding side of the polyhedron, in which case the polyhedron is then configured essentially from bars which form its edges.

In Figure 14, a plurality of, for example six, planar plates 47 are joined together by welding, or by screw connections (not illustrated), to form a pyramid-like connecting element 48 which is open at the top. Each plate 47 has, for example, the function of a plate 28 according to Figure 7.

As a variant to this, it is likewise possible for the plates 9 according to Figure 2 to be formed such that they correspond to the plates 47 according to Figure 14. The connecting element 48 then comprises, for example, as has already been explained analogously in relation to Figure 13, bars, which form the edges of the connecting element 48, to which the plates 47, for example, are screwed.